APPLICATION OF X-RAY FLUORESCENCE ANALYSIS TO LITHOLOGY INTERPRETATION AND GEOSTEERING IN THE ROTLIEGEND FORMATION

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Introduction

Development of hydrocarbon exploration involves using sophisticated methods allowing for quick and precise lithological interpretation. Reconstruction of lithological profile is often created during drilling. Advanced geosteering procedures are set up basing on various methods (Morton, 2007, Stilwell et al., 2013, Yarbrough, et al. 2019).
Our research was focused on real-time lithology modelling of Rotliegend formation from the area of Polish Lowlands. Models were firstly developed basing on a chemical (XRF) and mineralogical (XRD) analysis of rock core form P4 borehole. The P4 was chosen to perform reference analyses as a twin well for the planned P5H and for its archival rock core availability. The collected data were used for geosteering when drilling horizontal borehole P5H

Samples and methods

Our team created a new core sampling methodology to obtain core material comparable to cuttings collected on the rig site. Representative rock material was sampled, split from a specified core interval and analyzed by the X-ray fluorescence device (Skupio, 2014). In order to identify small chemical composition changes of the monotonous Rotliegend profile, both the main and trace elements were analysed. Additionally, precise chemical analyses were conducted to calibrate the handheld XRF spectrometer in order to obtain more precise geochemical results. Selected samples were also subjected to quantitative X-ray diffraction (QXRD) analysis in order to establish mineralogical profile (Kowalska, 2013).

Results

Rock chemical composition was correlated with the established mineralogy. The collected data were used to obtain appropriate lithology interpretation of the reference borehole profile. Six zones characterised by specific chemistry and mineralogy were recognised in the Rotliegend section of P4 well (Fig. 1.)Analogical XRF analyses were performed on cuttings while drilling the horizontal well P5H Sample preparation, XRF measurements and data interpretation were made in real time on the rig site during P5H completion. Comparison of newly provided results from cuttings with P4 chemical and lithological profile were used to control and correct the trajectory of the horizontal well. Elemental composition data allowed to recognise zones distinguished in the reference borehole P4 and to perform final horizontal correlation (Fig. 1.).

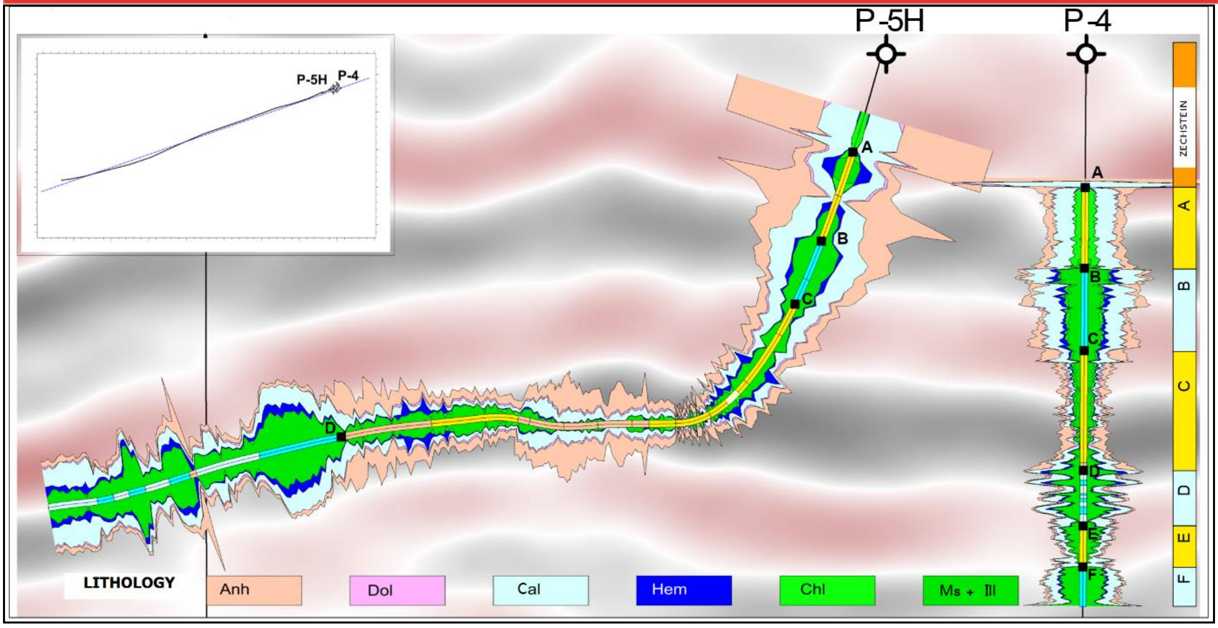

Figure 1. *Cross-section between between P-4 and P5H boreholes, showing the correlation of lithological profiles. A-F – recognized zones in Rotliegend profile.*

Abbreviations: Anh- anhydrite; Dol- dolomite; Cal- calcite; Hem- hematite; Chl- chlorite; Ms- muscovite; Ill- illite.

Conclusions

The applied methodology was a basis for geosteering during P5H realization and allowed for precise lithological interpretation by tracing chemical composition changes in the examined profiles. Both the quick sample preparation and analysis allowed for faster data acquisition than LWD measurement. Lithology interpretation for P5H borehole was done without well logging data, only by modelling the XRF data according to reference well. The developed technique gives precise and cost effective results for geosteering and horizon correlation.

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